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Art X.—The Genus Cycloclypeus in Victoria.

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Introduction.

The foraminiferal genus *Cycloclypeus* in Victoria, occurs within very restricted limits in the Batesfordian horizon of the Middle Miocene. The genus was first recognized in Victoria by F. Chapman, who, in 1910, recorded *Cycloclypeus pustulosus* Chapman (1905) in association with *Lepidocyclina* from the polyzoal limestone beds at Batesford near Geelong. In 1930 Chapman and the present author described *Cycloclypeus communis* Martin from the polyzoal limestones of Batesford and Le Grand's Quarry near Longford as well as from No. 3 Bore, Parish of Darriman, no reference being made to the form previously recorded from Victoria by Chapman as *C. pustulosus*. This latter species was described by Chapman from Wai Malikoliko, Santo, New Hebrides, from beds apparently of Lower Miocene age, whilst *C. communis* was originally described by Martin from Middle Miocene beds in Java.

Cycloclypeus is found not only as a fossil but also living in recent seas, especially in the Indo-Pacific region. Deposits of limestones composed almost entirely of tests of *Cycloclypeus* and of Miocene age, occur in North-West Australia, and in New Guinea, whilst a species is fairly common in the Upper and New Quarries at Batesford. The genus is comparatively rare in European fossiliferous deposits, and its only record of recent occurrence in that region is from the Adriatic Sea.

It is not intended in the paper to discuss in detail the morphology and anatomy of the genus. This has been done in some detail by Tan Sin Hok (1932) in his work "On the Genus *Cycloclypeus* Carpenter." In the present short account of *Cycloclypeus* in Victoria the specific determination is made on a study of the nepionic apparatus with some consideration of the external characters. All figured specimens are in the Commonwealth Palaeontological Collection at Canberra.

Systematic Study of the Genus Cycloclypeus.

The first worker to study the genus was Carpenter in 1856, who erected it on recent specimens collected " from a considerable depth of water off the coast of Borneo." His diagnosis of the genus, except for a few minor alterations, still holds good. Tan (1932, p. 15), gives a description of the genus based on Carpenter's specimens—" The *Cycloclypei* can be defined as follows: Shell flat, with or without umbo, with or without pillars, with or without annuli, with or without radial ribs. Contour circular or stellate. Consisting of one single layer of equatorial chambers, in both generations composed of a planispiral nepionic apparatus, surrounded by a neanic apparatus constituted of chambers in concentric arrangement. Sidewalls perforated, without lateral chambers. Marginal cord, septa and sidewalls with canal-system."

Martin, in 1880, was the first to observe the embryonic apparatus in megalospheric specimens.

In 1900, Chapman, in his work on Funafuti, discovered the microspheric form of *Cycloclypeus*. His comparison of this form with the structure of *Heterostegina* is still recognized. Further researches have been carried out by Silvestri and Hofker, whilst Tan Sin Hok (1932) has made extensive investigations regarding both the microspheric and megalospheric forms throughout the Netherlands Indies. Later still, in 1938, Cosijn made a " statistical study of the phylogeny " of the Cycloclypei from Spain.

Both the microspheric and megalospheric generations are found in Victoria, the former being exceedingly rare. The terminology used in describing these forms is based on the works of Tan and Cosijn and is listed below.

Megalospheric Form.

Three distinct stages of growth are discernible in the development of a *Cycloclypeus* shell.

1. *Protoconch or embryonic stage.*—The protoconch consists of two chambers, a rounded central one known as the proloculum, and a kidney-shaped one (the second protoconchal chamber) which surrounds the proloculum. These two chambers constitute the embryonic apparatus, and in the Victorian Cycloclypei they are comparatively small but uniform in size.

2. *Nepionic stage.*—(i) The nepionic apparatus is the series of spiral whorls which originate from the protoconch. The chambers comprising this apparatus show two stages of growth. (*a*) The operculinoidal substage. This is represented by a simple individual chamber, which envelopes one side of the protoconch. This feature is constant in the Victorian specimens. (*b*) The heterosteginoidal substage. This is represented by the divided chambers which follow immediately on the operculinoidal chamber.

(ii) The primary septa or nepionic septa are long septa which run in a vertical direction in the shell, dividing the nepionic whorls into chambers known as primary or nepionic chambers.

(iii) The secondary septa are short septa dividing the nepionic chambers into oblong or rectangular chambers.

(iv) The marginal cord represents the limit of the heterosteginoidal substage.

3. *Neanic or Cyclic stage.*—The neanic stage follows after the development of the nepionic stage, commencing when the spiral or heterosteginoidal method of growth is replaced by the cyclic method, which continues throughout the growth of the shell. This is the true *Cycloclypeus* character.

Microspheric Form.

The microspheric generation is always much larger than the megalospheric form and frequently much less ornamented.

1. The proloculum consists of a single rounded chamber.

2. The nepionic stage consists of a number of small chambers arranged in a spiral.

(i) The operculinoidal substage consists of numerous undivided chambers, instead of one as in the megalospheric form. The microspheric generation in the sections of the few Victorian specimens available has ten chambers.

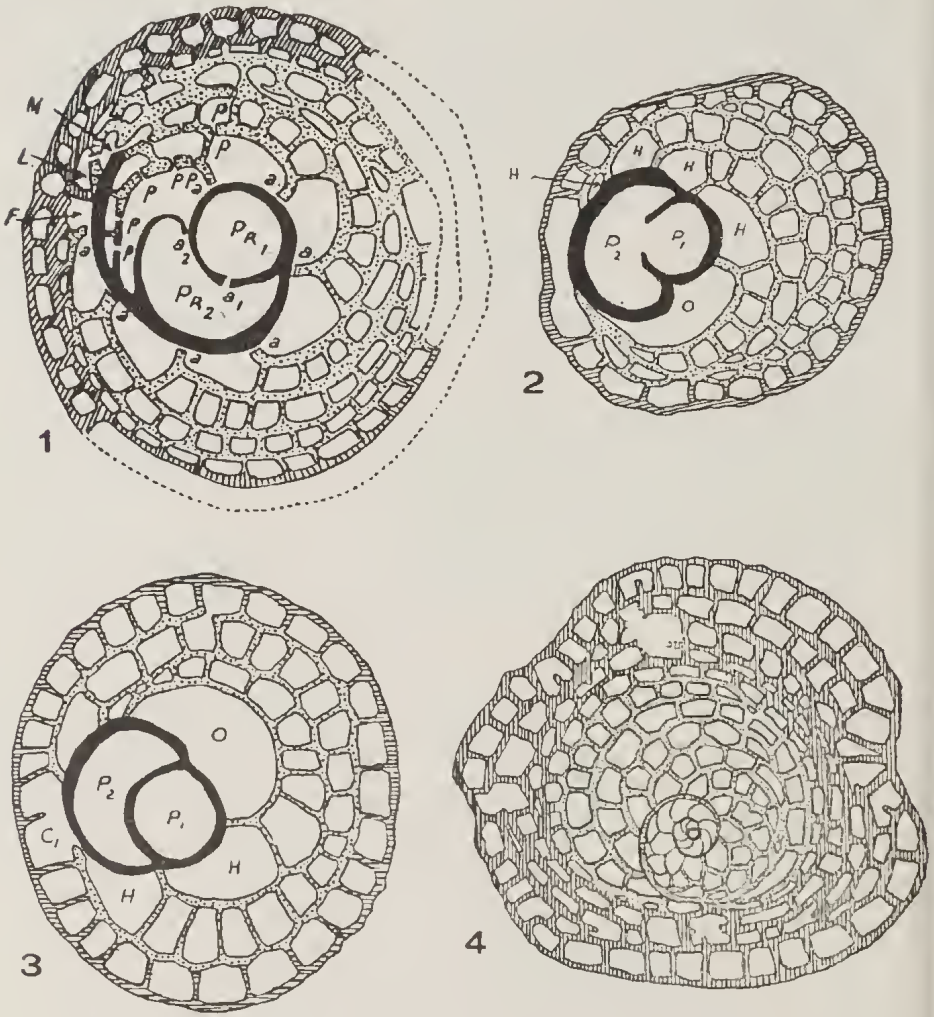
(ii) The heterosteginoidal substage consists of numerous divided chambers which number eighteen in the only satisfactory section of a Victorian specimen.

3. The neanic or cyclic stage is represented where the arrangement of the chambers passes from the spiral to the cyclic.

The structure of more than sixty horizontal sections of megalospheric specimens of *Cycloclypeus* from Victoria has been studied in this investigation, the number of specimens available being nearly four hundred, of these three hundred were from Batesford (one hundred from the New Quarry and two hundred from the Upper Quarry). Only six specimens were available from the Hamilton Bore, and more than one hundred from Gippsland, thirty being from Le Grand's Quarry, twenty from No. 6 Bore, Parish of Colquhoun (Lakes Entrance), and forty from No. 7 Bore. The number of microspheric specimens available was six.

Whilst the external characters show considerable variation, the study of the nepionic septa of numerous specimens leads to the conclusion that only one species is present. This form is being designated *Cycloclypeus victoriensis*. Variation in external sculpture is distinctive in different areas, although at times these variations tend to merge into one another. One variation is so persistent in the Gippsland region that it has been given varietal rank—*C. victoriensis* var. *gippslandica* nov. Tan's remarks on

this group of Cycloclypei (p. 62) might be quoted here: "The great variability of the sculpture of the megalospheric generation is not only shown by specimens of the same population, but also the specimens of separate populations show more or less marked constant differences. It appears that almost each locality yields its own phenotype."



Figs. 1, 2, 3, 4.—Black, embryonic stage or protoconch; stippled, nepionic stage; hatched, neanic or cyclic stage. Fig. 1. *Cycloclypeus indopacificus* (after Tan) PR_1 and PR_2, 1st and 2nd protoconchal chambers; a_1 and a_2 apertures; seven nepionic septa; P_1 passages through nepionic septa; *a*, apertures; F, 1st chamberlet of 1st neanic chamber; L, last chamberlet of 1st neanic chamber; M, end of marginal cord. Fig. 2. *C. indopacificus* (after Tan) and fig. 3 *C.* cf. *guembelianus* (after Tan) P_1 and P_2, 1st and 2nd protoconchal chambers; O, operculinoidal substage; H, heterosteginoidal substage; C_1, regular neanic chambers. Fig. 4. Microspheric form (after Tan) nepionic stage with 21 chambers, 10 in operculinoidal substage and 11 in heterosteginoidal substage. Chambers bounded by fine lines, nepionic stage.

The external features of the megalospheric generation of *Cycloclypeus* in Victoria are summarized as follows:—

(*a*) *Cycloclypeus victoriensis*, sp. nov., forma typica—Umbo distinct; pillars strong not only on umbo but on flange, where they are arranged concentrically and with rows fairly close together. Shell fairly thick. Specimens practically uniform in size. Diameter 6 mm. Typical of Batesford and Hamilton with a few specimens at Le Grand's Quarry, Gippsland. Pl. XII., fig. 1.

(*b*) *Cycloclypeus victoriensis* var. *gippslandica*, nov.—Umbo distinct, but not prominent; pillars fairly strong on umbo but finer on flange, where arranged concentrically, but with rows farther apart than in *C. victoriensis*. Test thinner and frequently larger than in the type species. Diameter 2–8 mm. Typical of the Gippsland bores and outcrops in the Glencoe-Stradbroke region, and in bores and outcrops east of Sale, rare at Batesford, absent at Hamilton. Pl. XIII., fig. 10.

Description of Species.

Family CAMERINIDAE.

Genus Cycloclypeus Carpenter.

CYCLOCLYPEUS VICTORIENSIS, sp. nov.

(Pl. XII., figs. 1-3, 5-8; Pl. XIII., figs. 9, 17; Pl. XIV., figs. 20-23; Pl. XV., figs. 26-28, 31-32.)

Cycloclypeus pustulosus Chapman, 1910 (non 1905), p. 295, pl. lii., fig. 6; pl. lv., fig. 4.

Cycloclypeus communis Chapman and Crespin, 1930 (non Martin 1880), p. 112, pl. vii., figs. 7, 8; pl. viii., figs. 9-13.

Cycloclypeus pustulosus Tan, 1932, p. 84.

Cycloclypeus communis Crespin (non Martin), 1936 (pars), p. 7, pl. i., figs. 10, 11.

Holotype.—(A) Megalospheric Generation.—Test circular in outline; umbo distinct, surrounded by a moderately thin flange. Slight annulus or fold immediately around umbo. Test covered with tubercules which are strong and irregularly arranged on umbo but in thirteen concentric rows on flange, which are fairly close together. The tubercules correspond with the annular divisions of the test. Towards marginal portion of test, they develop into radial ridges of varying length extending from the outside margin of each annulus towards periphery of preceding ring of chambers. Diameter 6 mm.; greatest thickness at umbo 1 mm.

The embryonic apparatus is represented by the protoconch which consists of two chambers, a central rounded one, the proloculum, and a kidney-shaped one partially surrounding the proloculum, the second protoconchal chamber. These chambers have a fairly thick shell wall (fig. 26). The embryonic stage is followed by the nepionic stage, the nepionic apparatus consisting

of almost a complete whorl containing ten septa including one operculinoidal and nine heterosteginoidal chambers. This stage is followed by the neanic or cyclic stage in which the majority of chambers are rectangular in shape. The marginal cord, a feature frequently difficult to secure in section, is present in figs. 26, 31, and is represented by a moderately thick wall.

In vertical section, the side walls which lie on either side of the equatorial layer are not thick and are pierced by pillars, which are numerous in the type specimen.

Locality.—White limestone in New Quarry, Batesford, near Geelong at north end of tunnel (collected by F. A. Cudmore). Com. Pal. Coll. No. 157.

Paratypes.—(*a*) Le Grand's Quarry.—The external characters of this specimen are similar to the holotype, except that the edge of the test is smooth and rounded. The nepionic septa are chiefly seven in number. The width of the test is 6 mm., which closely approximates the type.

(*b*) Hamilton Bore at 48–53 feet.—The external features are similar to the holotype, the pillars appearing much stronger in the Hamilton form, due to the preservation of the shell. All the Hamilton specimens are strongly ironstained. A second specimen shows the pillars not quite so prominent, the test being rather smooth towards the margin. The width of both specimens is 5 mm. Horizontal sections were difficult to obtain owing to the mode of preservation.

Observations.—The Batesford specimens of *Cycloclypeus* were recorded by Chapman in 1910 as *C. pustulosus* Chapman (1905), and later by Chapman and Crespin (1930) as *C. communis* Martin, the previous reference as *C. pustulosus* being disregarded. In this latter paper, specimens were also figured from Le Grand's Quarry, Gippsland. No comparison has been made in the present paper with the megalospheric form of *C. pustulosus*, as specimens of that species were not available for this purpose. A horizontal section was not given by Chapman in the original paper, whilst the figure showing the external characters is in no way comparable with the Victorian forms. The Lepidocyclinae associated with *C. pustulosus* in the type locality indicate that this species belongs to a horizon older than that in which *C. victoriensis* is recorded. No specimens similar to that figured from the Batesford limestone could be found amongst the numerous examples examined during this investigation.

Tan (1932, p. 84) in his remarks on *C. pustulosus* as figured by Chapman from the Batesford limestone, states that no specimen corresponding to Pl. 52, fig. 6 could be found in the Javan material. Unfortunately Tan had not seen the figure of the species from the type locality in the New Hebrides, but he does consider that Pl. 55, fig. 4 in the Batesford paper shows relationship with *C. indopacificus*.

As regards *C. communis* Martin, the average diameter of the megalospheric specimens of that form as given by Martin is 12 mm., with the microspheric (not recognized by Martin) up to 40 mm. These dimensions greatly exceed the two generations of the Victorian species. The arrangement of the nepionic septa in *C. victoriensis* is different from that shown by Martin in *C. communis*. In Chapman and Crespin's paper (1930), fig. 13 represents a section of a megalospheric specimen, not microspheric as stated. Douvillé's figures of *C. communis* (1909) from Madagascar show the test to be very closely ornamented with pustules. Tan takes this form (fig. 12) as his type for *C. indopacificus*.

The Victorian Cycloclypei are closely related to *C. indopacificus* of Tan. This authority has suggested that the Victorian form may be slightly more primitive than the Netherlands Indies form, this suggestion being based on the larger number of nepionic septa in the Victorian specimens. Tan considers that the greater the number of nepionic septa the more primitive or older the species, the fewer the septa the younger the form. Six nepionic septa are most frequent in *C. indopacificus*, with variation from four to six, whilst in its variations they range from four to seven, rarely eight. In *C. victoriensis*, the most frequent number is from seven to nine, with three specimens showing ten and one showing thirteen (Pl. XV., fig. 28). In the specimens from the Upper Quarry, Batesford, nine septa are most frequent, whilst in the Batesford New Quarry they number seven, and from Le Grand's Quarry seven.

In studying the populations in a particular locality and bed, certain variations are noticeable. In the Upper Quarry at Batesford where the specimens are numerous, the tests of *C. victoriensis* are uniform in size, being circ. 5 mm. in diameter. Here the type specimen is associated with a comparatively smooth form with a diameter of 3 to 5 mm., whilst the microspheric generation is also represented. The number of nepionic septa varies from seven to ten, with nine the most frequent. In the section in the New Quarry, the diameter of the tests of *C. victoriensis* forma typica, varies from 4 to 8 mm., with the average 6 mm. The number of nepionic septa varies from seven to ten with nine the most frequent. In this section the smooth form and the microspheric generation are absent, but a variety, *C. victoriensis* var. *gippslandica*, is sparingly present.

Very few specimens are available from the Hamilton Bore, these being recorded between the depths of 36 to 38 feet and 48 to 80 feet. All the tests measure 5 mm. and are strongly iron-stained, the internal structure being usually masked by glauconite replacement.

In Gippsland *C. victoriensis* is recorded from Le Grand's Quarry near Longford, where it is fairly common, the average

diameter being 5 mm. The nepionic septa number seven. It is associated with *C. victoriensis* var. *gippslandica, C. victoriensis* forma typica occurs only in two borings throughout Gippsland.

Occurrence.—*C. victoriensis* has been recorded from the following outcrops and borings in Victoria, where it is always associated with *Lepidocyclina.*

Outcrops: (i) Port Phillip Region.—Upper Quarry (Australian Portland Cement Co.), Batesford, near Geelong (Forms A and B), (coll. F. A. Singleton); New Quarry, Batesford, at N. end of tunnel (coll. F. A. Cudmore); Flinders (Forms A and B) (coll. I.C.).

(ii) Gippsland Region.—Le Grand's Quarry, south of Longford, Allot. 13, Parish of Glencoe (Forms A and B) (coll. I.C. and Victorian Mines Department).

Borings: (i) Western Victoria.—No. 1 Government Bore, Hamilton, Parish of Yulecart (4 chains south from bridge over Muddy Creek) at 36-38 feet and 48 to 80 feet.

(ii) Gippsland Region.—No. 14 Bore, Parish of Stradbroke at 705 feet, and No. 1 Bore, Parish of Nindoo at 190 feet.

(B) Microspheric Generation (figs. 6, 23).—(*a*) Batesford specimen—Test large, rather thick, about twice the size of the megalospheric form, measuring about 10 mm. (Complete specimens not available). Umbo district. Test faintly ornamented with pillars, irregularly arranged on umbo, concentrically on flange.

The embryonic stage consists of a protoconch, represented by small, rounded, single chambers. This is followed by a spiral (nepionic) apparatus consisting of twenty-eight chambers (nepionic septa). The operculinoidal substage which immediately follows the embryonic stage contains ten undivided chambers, which are followed by eighteen divided chambers constituting the heterosteginoidal substage. The neanic stage with its cyclic arrangement of chambers immediately follows until the margin of the shell is reached. The chambers in the neanic stage almost quadrate in shape when immediately surrounding nepionic stage, then gradually becoming more and more elongated towards margin of shell.

(*b*) Flinders specimen—Test large, moderately thick, ornamented with fine pillars arranged concentrically on flange. Umbo distinct, represented by swelling towards centre of shell. Diameter—circ. 10 mm.

Observations.—It is unfortunate that specimens of the microspheric form are so rare. As a result of this scarcity the description of the internal characters has been based on one specimen but Tan has shown that the characters of the embryonic and nepionic chambers in the microspheric form are fairly constant. Only three specimens were available from Batesford, all from the Upper Quarry section. One example was available from Flinders, while no specimen was found in the Hamilton Bore.

Occurrenee.—Upper Quarry, Batesford, near Geelong (figured speeimen of exterior pres. W. J. Parr; sectioned speeimen, coll. F. A. Singleton); and Flinders.

Age.—Middle Miocene (Batesfordian).—The stratigraphical horizon is fairly high in the Middle Miocene, and the equivalent of *f 2* stage in the Netherlands Indies, New Guinea, Papua and North-West Australia. This stage probably eorrelates with the upper portion of the Burdigalian of Europe. The *C. indopacificus* type of nepionic septa is characteristic of this horizon.

CYCLOCLYPEUS VICTORIENSIS var. GIPPSLANDICA, nov.

(Pl. XII., fig. 4; Pl. XIII., figs. 10-16, 18; Pl. XIV., figs. 19, 24, 25, 29, 30.)

Cycloclypeus communis Crespin non Martin, 1936 (pars), p. 7.

Holotype of variety.—(A) Megalospheric Generation.—Specimen incomplete. Umbo distinct, pillars fairly strong on umbo but finer on flange, where arranged in seventeen concentric rows whieh are farther apart than in *C. victoriensis*. Test larger than in type. Diameter 8 mm.

Embryonic apparatus as in type. Nepionie septa—six. Chambers in the neanic stage tend to become elongated towards margin.

Locality.—No. 5 Bore, Parish of Glencoe at 50 feet. (Com. Pal. Coll. No. 163.)

Paratypes.—(*a*) Parish of Darriman, No. 3 Bore at 439 feet. Test similar to type. Diameter 7 mm.

(*b*) Parish of Nindoo, No. 1 Bore at 190 feet. Umbo less prominent than in (*a*). Test thin and rather wavy. Diameter 6 mm.

(*c*) Skinner's section, Parish of Wuk Wuk, Mitchell River. Umbo not prominent, pillars developing into ridges towards margin of shell. Specimens translucent. Diameter 6 mm.

(*d*) Parish of Colquhoun, No. 7 Bore, 620 feet. Test fairly smooth with pillars scattered irregularly over surface. Umbo indistinct, represented by gradual thickening of side walls towards centre of shell. Nepionic septa, eight. Diameter 4 mm.

Observations.—*C. victoriensis* var. *gippslandica* is found in association with the "forma typica" in Gippsland in Le Grand's Quarry, and in No. 1 Bore, Parish of Nindoo at 190 feet. In no locality was a complete specimen available so dimensions are only approximate.

The main distinction between the two forms lies in the larger size and different and finer ornamentations of the variety. The nepionic septa range from six to eight with six the most frequent. There is also some variation in size and ornament in different populations. At Le Grand's Quarry, except for the presence of

the type species, the majority of the specimens are typical of the type of the variety. In No. 1 Bore, Parish of Nindoo at 190 feet, specimens are comparatively common and some variety in ornamentation and stages of growth is illustrated. The limbation of the outer chambers is very strong, being both radial and concentric. The shell surface is rectangularly reticulated. The dimensions range from 1 mm. up to 8 mm. The shell has not grown beyond the heterosteginoidal stage in the smallest specimens, the surface of the test being smooth and transparent in some and strongly beaded in others. In some of the larger specimens the pillars are so developed as to form strong ridges between the septa. The examples from Skinner's section along the Mitchell River, about 10 miles to the north-east of the Nindoo Bore, show similar characteristics.

C. victoriensis var. *gippslandica* is well represented in the Lakes Entrance (Parish of Colquhoun) bores, specimens varying from 2 to 6 mm. in diameter. The nepionic septa number from six in No. 4 Bore (Pilot Station) to eight in No. 7 Bore (Lake Bunga). Tests are usually rather worn and broken, but in No. 8 Bore (North Arm) they are well preserved and very common. Unfortunately these specimens were not available for inclusion at the time when the plates were assembled.

Occurrence.—Outcrops: (i) Port Phillip Region.—Batesford at top of the New Quarry at the north end of the tunnel (rare).

(ii) Gippsland Region.—Le Grand's and Brock's Quarries south of Longford, Parish of Glencoe (Forms A and B); along the Mitchell River, at Skinner's section, Parish of Wuk Wuk; and north cliff, east of Hillside Bridge, Parish of Wy Yung.

Borings: Gippsland Region.—Parish of Glencoe, No. 5, 50 feet; Parish of Glencoe South, Tanjil-Pt. Addis No. 2 Bore, 560-650 feet; Texland Bore, 330 feet; Parish of Stradbroke, No. 14 Bore, 745 feet; in No. 16 Bore, 610 feet; Parish of Darriman, No. 3 Bore, 379 and 439 feet; Parish of Dulungalong, Signal Hill Bore, 1,573 feet; Parish of Nindoo, No. 1 Bore, 190 feet; Parish of Coongulmerang Steam Drill, 914-916 feet; Parish of Colquhoun, No. 3 Bore (Nungurner), 891 and 893 feet; in No. 4 Bore (Pilot Station), 855 and 860 feet; No. 6 Bore at 887 feet, No. 7 Bore at 620 feet and No. 8 Bore between 565 feet and 590 feet.

(B) Microspheric Generation.—(*a*) Le Grand's Quarry, south of Longford.—Test large, thin, almost smooth but faint pillars are present arranged concentrically on flange. Umbo indistinct. Diameter 12 mm.

The heterosteginoidal chambers are visible but most of the central portion has been altered. In the neanic or cyclic stage, the chambers are elongated rectangular and are fairly close together, this attenuation becoming very pronounced towards margin of shell.

(*b*) Brock's Quarry, south of Longford.—Test large, thin, with uneven surface which is ornamented with faint pillars arranged fairly closely together and concentrically on flange. Twenty-six annuli, visible and irregularly arranged, becoming farther apart as margin of shell is reached, indicating the narrow, elongated chambers shown in horizontal section. Diameter 16 mm.

Observations.—The arrangement of the pillars on the surface of the test and the elongated rectangular shape of the chambers, as shown in horizontal section, leaves little doubt that these specimens from Gippsland represent the microspheric generation of *C. victoriensis* var *gippslandica*. They are also larger than the microspheric forms of *C. victoriensis* from Batesford and Flinders. At the same time, the microspheric specimens of both *C. victoriensis* and *C. victoriensis* var. *gippslandica* are proportionally larger than the megalospheric ones. As with *C. victoriensis*, specimens available for examination were few. Two were present in the material from Le Grand's Quarry and one each from Brock's Quarry and No. 1 Bore, Parish of Nindoo.

Occurrence.—Gippsland Region.—Le Grand's Quarry and Brock's Quarry, south of Longford in the Parish of Glencoe; No. 1 Bore, Parish of Nindoo at 190 feet.

Age.—Middle Miocene (Batesfordian).

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References.

Carpenter, W. B., 1856.—Researches on the Foraminifera 2d Series: On Orbulina, Alveolina, Cycloclypeus and Heterostegina. *Phil. Trans. Roy. Soc. London*, 146, p. 555.

Caudri, C. M. B., 1932.—De foraminiferen-fauna van eenige Cycloclypeus houdende gesteenten van Java. *Verhand. geol. mijnb. Gen. Geol. Series*, ix., p. 171-204.

Chapman, F., 1900-03.—On Some New and Interesting Foraminifera from the Funafuti Atoll, Ellice Islands. *Journal Linnean. Soc. Zoology* 28, p. 22 et seq.

————, 1905.—Notes on the Older Tertiary Foraminiferal Rocks on the West Coast of Santa, New Hebrides. *Proc. Linn. Soc. N.S.W.* xxx. (2), pp. 261-274.

————, 1910.—A Study of the Batesford Limestone. *Proc. Roy. Soc. Vic.*, n.s., xxii. (2), pp. 263-314.

————, and Crespin, I., 1930.—Rare Foraminifera from Deep Borings in the Victorian Tertiaries—Victoriella, gen. nov., Cycloclypeus communis Martin, and Lepidocyclina borneënsis Provale. *Proc. Roy. Soc. Vic.*, n.s., xlii. (2), pp. 110-115.

————————, 1932.—Rare Foraminifera from Deep Borings. Part III., *Proc. Roy. Soc. Vic.*, n.s., xliv. (1), pp. 92-99.

————————, 1932.—The Tertiary Geology of East Gippsland, Victoria, as shown in Borings and Quarry Sections. *Pal. Bull. No. 1.*

Cosijn, A. J., 1938.—Statistical Studies on the Phylogeny of some Foraminifera. Cycloclypeus and Lepidocyclina from Spain, Globorotalia from the East-Indies.

Crespin, I., 1936.—The Larger Foraminifera of the Lower Miocene of Victoria. *Pal. Bull. No. 2*, pp. 1-13.

Cushman, J. A., 1933.—Foraminifera—Their Classification and Economic use.

Douvillé, R., 1909.—Lépidocyclines et Cycloclypeus malgaches. *Ann. Soc. Roy. Zoologique et Malacologique Belgique* 44, p. 125 et seq.

Galloway, J. J., 1933.—A Manual of Foraminifera.

Hofker, J., 1927-30.—The Foraminifera of the Siboga Expedition I. and II. *Résultats Scientif. Siboga Exp. Leiden.*

Martin, K., 1880.—Die Tertiarschichten auf Java Foraminifera. pp. 150-164.

————, 1891.—Die Fossilien von Java. Anhang: Die Foraminiferenführende Gesteine. Studien über Cycloclypeus und Orbitoides. *Samm. Reichs. Mus. Leiden. Band.* 1, pp. 1-12.

Rutten, L., 1913.—Studien über Foraminiferen aus Ost Asien. *Samm. Geol. Reichs. Mus. Leiden.* Ser. I., Bd. ix., pp. 281-325.

Silvestri, A., 1907.—Considerazioni paleontologiche e morfologiche sui generi Operculina, Heterostegina, Cycloclypeus. *Boll. Soc. Geol. Italia*, 26, p. 29 et seq.

Tan Sin Hok, 1930.—Over Cycloclypeus; voorloopige resultaten eener biostratigrafische studie. *De Mijningenieur* 1930, p. 233 et seq.

————, 1931.—On Cycloclypeus. Its Phylogeny and Signification for the Biostratigraphy in General and for the Stratigraphy of the Tertiary of the Indo-Pacific Region. *(Extract) Verhand. 6de Ned. Ind. Natuurw. Congress 1931.*

————, 1932.—On the Genus Cycloclypeus Carpenter, Pt. I. and an appendix on the Heterostegines of Tjimanggoe, S. Bantam, Java. *Weten. Meded. No. 19, Dienst. Mijn. Neder. Ind.*, pp. 1-194.

Van der Vlerk, I. M., 1923.—Een Nieuwe Cycloclypeus-soort van Oost Borneo. *Samm. Geol. Reichs. Mus. Leiden.* 10, 1923, p. 127 et seq.

————, 1925.—A Study of Tertiary Foraminifera from the "Tidoengsche Landen" (E. Borneo). *Weten. Med. No. 3, Dienst. Mijn. Neder. Ind.*, pp. 13-32.

Yabe, H., 1918.—Notes on a Carpenteria Limestone from B.N. Borneo. *Sci. Rep. Tôkohu Imp. Univ.*, 2nd Series (Geol.), pp. 15-30.

Explanation of Plates.

Cycloclypeus victoriensis, sp. nov.

Plate XII.

Fig. 1.—*Cycloclypeus victoriensis*, sp. nov. N. end of tunnel, New Quarry, Batesford. Exterior of test of Megalospheric specimen. Holotype. No. 157. × 8.

Fig. 2.—Upper Quarry, Batesford. Megalospheric. Paratype. No. 158. × 9.

Fig. 3.—N. end of tunnel, New Quarry, Batesford. Megalospheric. Paratype. No. 159. × circ. 9.

Fig. 4.—Var. *gippslandica* nov. New Quarry, Batesford. Megalospheric. Paratype. No. 160. × 9.

Fig 5.—*C. victoriensis*, sp. nov. Upper Quarry, Batesford. Megalospheric. Smooth specimen. Paratype. No. 161. × 8.

Fig. 6.—Upper Quarry, Batesford. Exterior of portion of microspheric specimen. No. 184. × circ. 6.

Fig. 7.—No. 1 Government Bore, Hamilton, Parish of Yulecart, at 48–53 feet, specimen ironstained. Megalospheric. Paratype. No. 162. × circ. 8.5.

Fig. 8.—Locality similar to Fig. 7. Specimen ironstained. Paratype. No. 83. × circ. 10.

Plate XIII.

Fig. 9.—*C. victoriensis*, sp. nov. Le Grand's Quarry, near Longford. Parish of Glencoe, Gippsland. Megalospheric. Paratype. No. 7. × circ. 8.

Fig. 10.—Var. *gippslandica* nov. No. 5 Bore, Parish of Glencoe, 50 feet. Megalospheric. Holotype of var. No. 163. × circ. 7.

Fig. 11.—Var. *gippslandica* nov. Le Grand's Quarry, near Longford, Parish of Glencoe. Megalospheric. Paratype. No. 164. × 9.

Fig. 12.—Var. *gippslandica* nov. No. 5 Bore, Parish of Glencoe, 50 feet. Megalospheric. Paratype. No. 165. × circ. 8.

Fig. 13.—Var. *gippslandica* nov. No. 1 Bore, Parish of Nindoo, Gippsland, at 190 feet. Megalospheric. Paratype. No. 166. × 9.

Fig. 14.—Var. *gippslandica* nov. No. 7 Bore, Parish of Colquhoun (Lake Bunga), Gippsland Lakes, at 620 feet. Small specimen typical of area. Paratype. No. 167. × 8.

Fig. 15.—Var. *gippslandica* nov. Skinner's section, Mitchell River, Parish of Wuk Wuk (near Bairnsdale). Megalospheric specimen showing regeneration of test. Paratype. No. 168. × 10.

Fig. 16.—Var. *gippslandica* nov. No. 3 Bore, Parish of Darriman, Gippsland, at 439 feet. Paratype. No. 169. × circ. 9.

Fig. 17.—*C. victoriensis*, sp. nov. No. 1 Bore, Parish of Nindoo, Gippsland, at 190 feet. Megalospheric, small specimen. Paratype. No. 170. × circ. 8.

Fig. 18.—Var. *gippslandica* nov. Skinner's section, Mitchell River, Parish of Wuk Wuk (near Bairnsdale). Megalospheric. Specimen showing fairly well marked annuli. Paratype. No. 171. × circ. 9.

Plate XIV.

Fig. 19.—Var. *gippslandica* nov. No. 4 Bore, Parish of Colquhoun (Pilot Station). Horizontal section showing seven large nepionic septa. Annuli in neanic stage irregular. Megalospheric. Tectotype. No. 172. × 20.

Fig. 20.—*C. victoriensis*, sp. nov. New Quarry, Batesford. Horizontal section of megalospheric specimen similar to external of Holotype, showing two protoconchal chambers, ten nepionic septa including one operculinoidal and nine heterosteginoidal chambers. Chambers in neanic or cyclic stage show regeneration. Tectotype. No. 172. × 20.

Fig. 21.—New Quarry, Batesford. Section slightly eccentric. Eight nepionic septa visible. Operculinoidal chamber indistinct. Neanic stage fairly regular. Megalospheric. Tectotype. No. 173. × 20.

Fig. 22.—Upper Quarry, Batesford. Ventral section of megalospheric form showing lateral chambers. Tectotype. No. 174. × 20.

Fig. 23.—Upper Quarry, Batesford. Microspheric specimen, showing elongated character of chamber towards margin of test. Tectotype. No. 175. × 12.

Fig. 24.—Var. *gippslandica* nov. No. 5 Bore, Parish of Glencoe, Gippsland, at 50 feet. Megalospheric. Embryonic apparatus abnormal. Five nepionic septa visible. Neanic or cyclic stage regular. Centre of test partially replaced by glauconite. Tectotype. No. 176. × 12.

Plate XV.

Fig. 25.—Var. *gippslandica* nov. No. 6 Bore, Parish of Colquhoun, Gippsland, at 887 feet. Sections showing nine large nepionic septa. Arrangement of chambers regular around nepionic apparatus. Tectotype. No. 177. × 20.

Fig. 26.—*C. victoriensis,* sp. nov. New Quarry, Batesford. Enlargement of embryonic and nepionic apparatus of Fig. 20. Marginal cord distinct. Tectotype. No. 172. × 40.

Fig. 27.—Upper Quarry, Batesford. Section showing eight nepionic septa, including one operculinoidal chamber and seven heterosteginoidal. Tectotype. No. 179. × 60.

Fig. 28.—Upper Quarry, Batesford. Section showing thirteen nepionic septa (one operculinoidal and twelve heterosteginoidal). Tectotype. No. 180. × 33.

Fig. 29.—Var. *gippslandica* nov. No. 6 Bore, Parish of Woodside, Gippsland. Centre of test filled with glauconite. Two protoconchal chambers of embryonic apparatus unusually large and thick-walled. Marginal cord distinct. Tectotype. No. 181. × 60.

Fig. 30.—Var. *gippslandica* nov. Le Grand's Quarry, near Longford, Parish of Glencoe. Section showing seven nepionic septa. Tectotype. No. 182. × 60.

Fig. 31.—*C. victoriensis,* sp. nov. New Quarry, Batesford. Section slightly oblique. Seven nepionic septa visible. Wall of embryonic apparatus thick. Marginal cord distinct. Tectotype. No. 183. × 60.

Fig. 32.—Upper Quarry, Batesford. Microspheric, specimen showing one protoconchal chamber, ten operculinoidal and eighteen heterosteginoidal chambers. Tectotype. No. 178. × 60.


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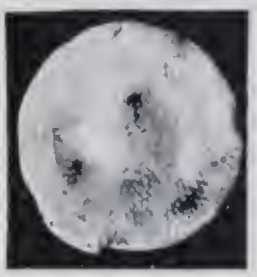
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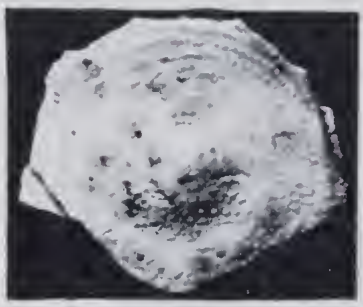
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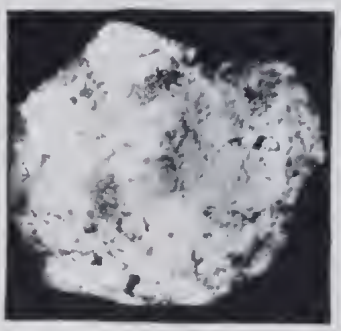
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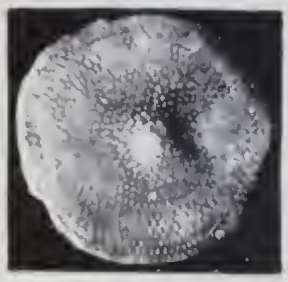
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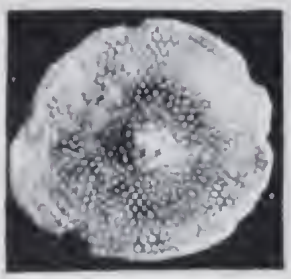
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Cycloclypeus from Victoria.

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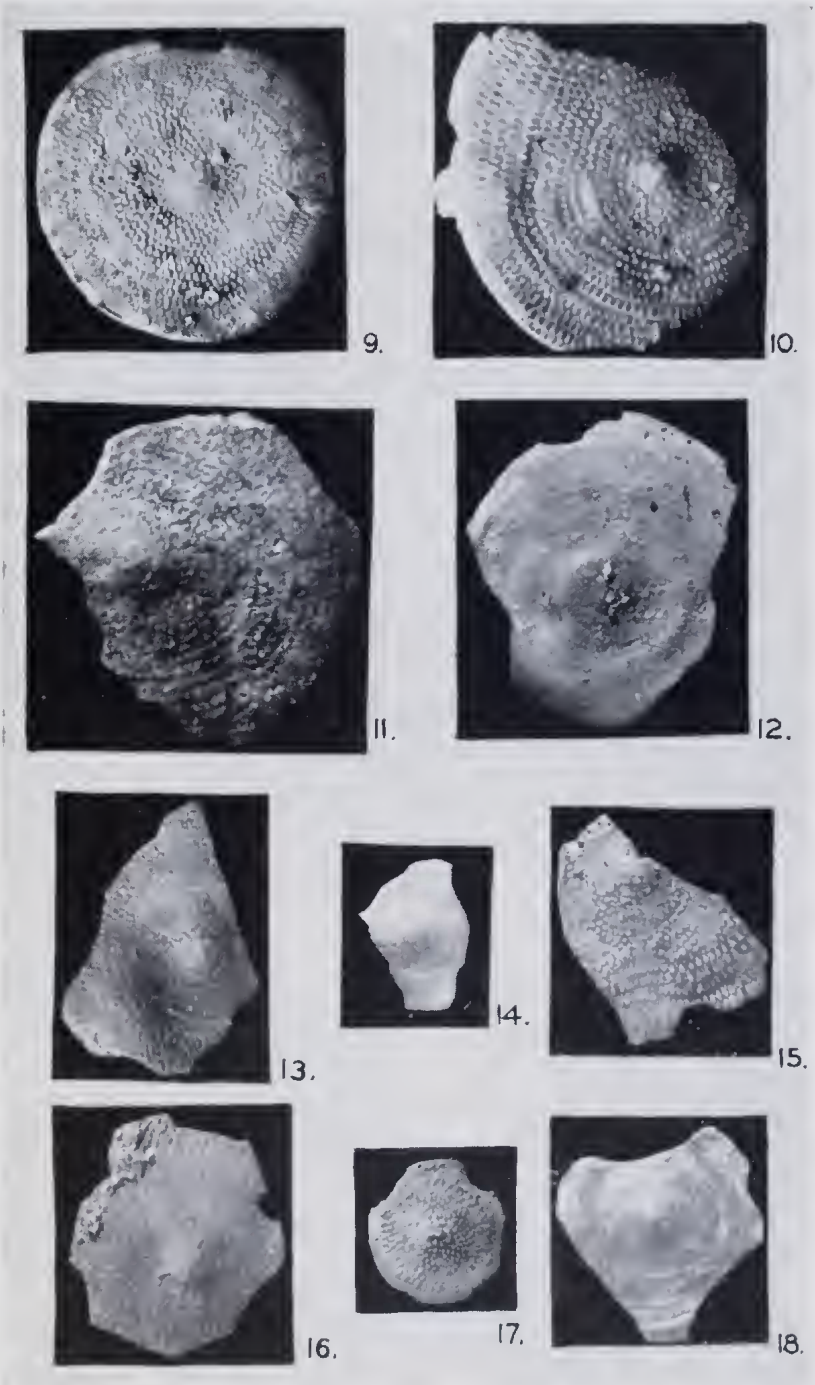

Cycloclypeus from Victoria.

[Page 317.]

Cycloclypeus from Victoria.

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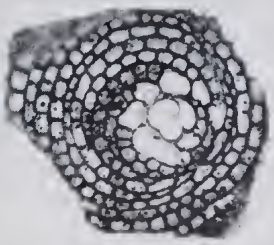

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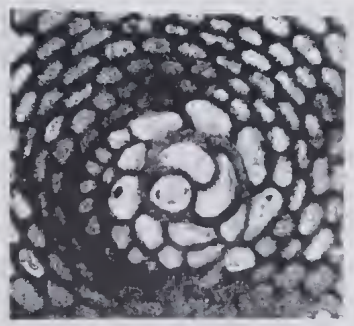

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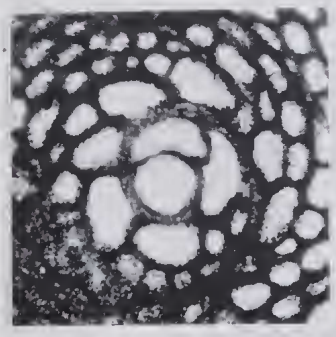

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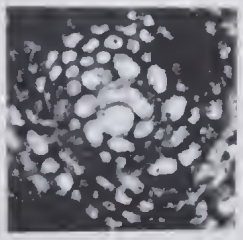

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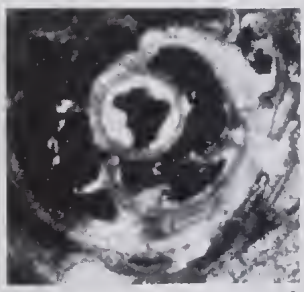

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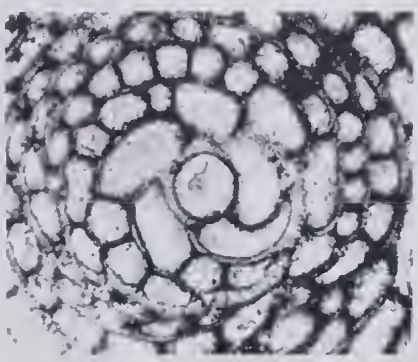

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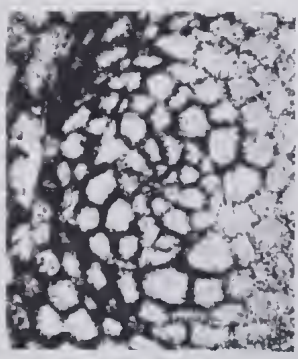

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Cycloclypeus from Victoria.

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